

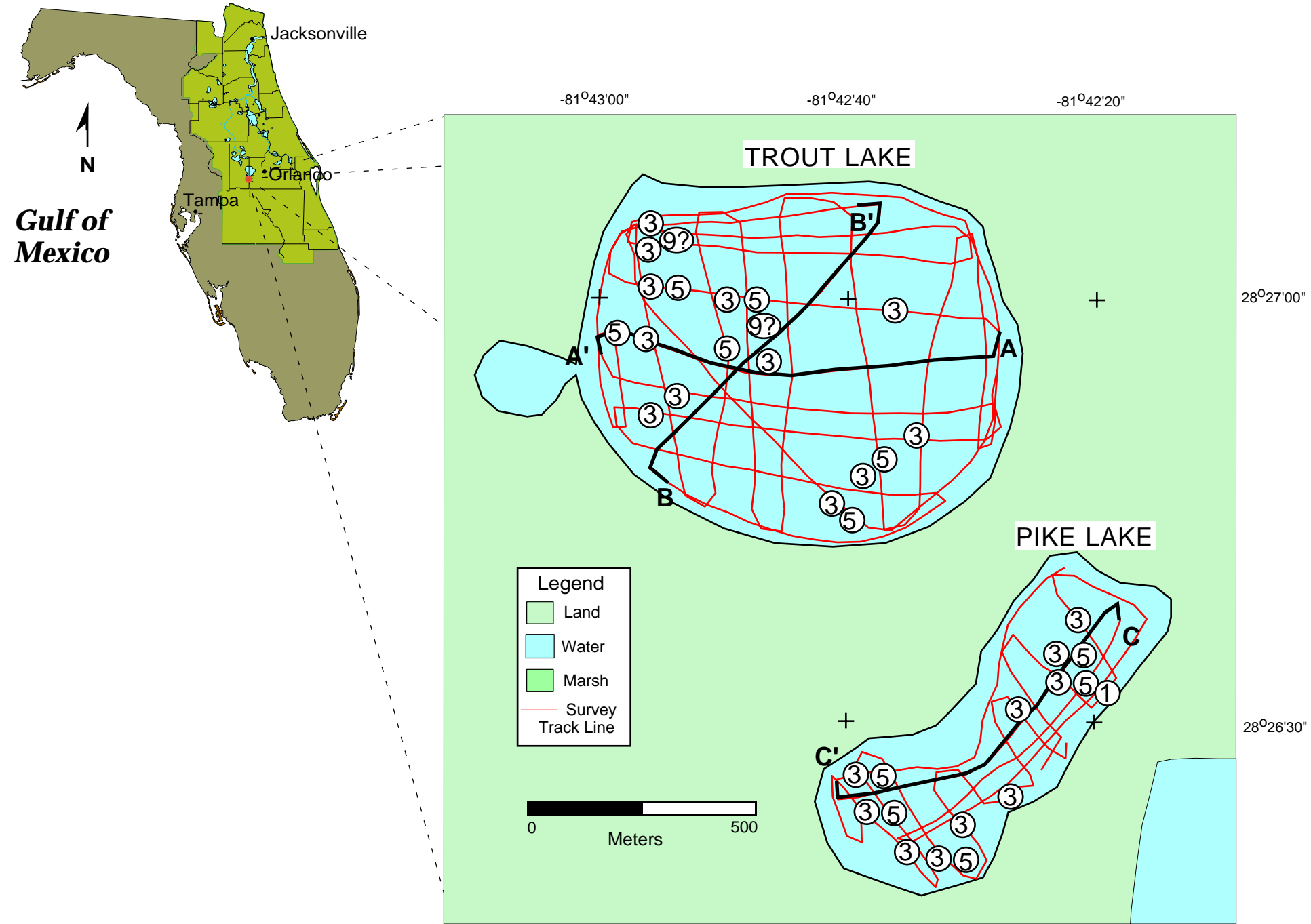


GEOLOGIC CHARACTERIZATION OF TROUT AND PIKE LAKES LAKE COUNTY, FLORIDA

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INTRODUCTION

The potential fluid exchange between lakes of northern Florida and the Floridan aquifer and the process by which exchange occurs is of critical concern to the St. Johns River Water Management District (SJRWMD). High-resolution seismic tools with relatively new digital technology were utilized in collecting geophysical data from > 40 lakes and rivers. The data collected shows the application of these techniques in understanding the formation of individual lakes and rivers, thus aiding in the management of these natural resources by identifying breaches or areas where the confining units are thin or absent between the water bodies, the intermediate aquifer and the Floridan aquifer.

This study was a cooperative investigation conducted from 1993 to 1996 by the SJRWMD and U.S. Geological Survey Center for Coastal Geology (USGS). Since 1989 there have been technical and hardware advances in the digital acquisition of high-resolution seismic data. The primary objective of this cooperative was to test newly developed digital high-resolution single-channel marine seismic continuous-profiling-equipment (HRSP) and apply this technology to identify subbottom features that may enhance leakage from selected lakes and the St. Johns River. The target features include: (1) identifying evidence of breaches or discontinuities in the confining units between the water bodies and the aquifer, and; (2) identifying areas where the confining unit is thin or absent.

METHODS

In cooperation with SJRWMD the USGS acquired and upgraded a digital seismic acquisition system. The Elics Delph2 High-Resolution Seismic System was acquired with proprietary hardware and software running in real time on an Industrial Computer Corp. 486/33 PC. Hard-copy data was displayed on a gray scale thermal plotter. Digital data was stored on a rewritable Magneto-Optical compact disk. Navigation data was collected using a Trimble GPS or PLGR (Rockwell) GPS. GeoLink XDS mapping software was used to display navigation.

The acoustic source was the Huntec Model 4425 Seismic Source Module and a catamaran sled with an electromechanical device. Occasionally, an ORE Geopulse power supply was substituted for the Huntec Model 4425. Power was set at 60 joules or 135 joules depending upon conditions. An Innovative Transducers Inc. ST-5 multi-element hydrophone was used to detect the return acoustical pulse. This pulse was fed directly into the Elics Delph2 system for storage and processing.

Forty-four line-km of HRSP data was collected from Lake Disston. A velocity of 1500 meters per second (m/s) was used to calculate a depth scale for the seismic profiles. Measured site specific velocity data is not available for these sites.

These surveys were conducted in part to test the effectiveness of shallow-water marine geophysical techniques in the freshwater lakes of central Florida. Acquisition techniques were similar but modifications were necessary. Data quality varied from good to poor with different areas and varying conditions. As acquisition techniques improved so did data quality in general. In many areas an acoustic multiple masked much of the shallow geologic data.

PHYSIOGRAPHY

Lakes Trout and Pike are among a cluster of small lakes in southeastern Lake County. The physiography is described by Brooks, 1981, as The Gap; an area of lower elevation, about 25 to 37m (85 to 120 ft) between the Sugarloaf Mountain region and No Name Ridge. The lower elevation is a result of increased erosion of the underlying limestone. The Gap and the flanking highlands are part of the Lake Wales Ridge, which is the topographic crest of Central Florida (Brooks, 1981). The Ridge is characterized by residual sand hills, relic beach ridges and paleo dune fields. The topography on either side of the ridge has been reduced to the water table, forming Green swamp to the southwest and Sawgrass Bays to the southeast. Lake level in December of 1995 was approximately 30 m (98 ft) NVGD. Trout lake, the larger of the two, is fairly circular, with a perimeter of 19 km and a surface area of about 1 sq. km. Pike lake is oblong with an area of 0.6 km and a perimeter of about 3.2 km.

GEOLOGIC CHARACTERIZATION

Seismic profiles from Lake Trout and Lake Pike show a hard bottom reflection, possibly well sorted sands, infilling a deeper karst surface (feature 1, profile A-A'). The strong bottom reflector leads to multiples seen throughout the data that obscure some of the record. The record is also partially obscured in areas where the lake bottom nears the surface. The acoustic characteristics and their interpretation in the two lakes are similar. The subsurface is characterized by numerous small low angle reflectors with high angle reflectors dipping toward their center (profile A-A', B-B', C-C', feature 5). Concentric reflectors extend to depth in the profile (feature 3). A distribution plot of these features (figure 1, red line) shows how they tend to define the areas of deeper water in the lakes (figure 1, blue line). The areas of subsidence seen within the lakes are well constrained and do not have the appearance of large subsidence or collapse sinkholes seen in other lakes. These localized areas of dissolution may lie directly over centers of increased karst activity. The competent overburden restricts lateral growth of the unstable region, creating a conduit for dissolution and fluid migration from the surficial waters to the Floridan aquifer. Discrete reflectors at 18 m (profile B-B', blue line) and 24 m (profile C-C', blue line) may represent the karst surface. Interpretations of a gamma log acquired from a well located approximately 1 mile to the south of the lakes (well L-0677, hillshade sheet #, profile A-A') show the top of the Ocala Limestone to be around 15 meters NVGD, #15 meters below lake level. The reflector seen in the profiles may represent the top of the Ocala Limestone. Differential dissolution in the Ocala Limestone could lead to subsequent subsidence in the overlying sediments of the Hawthorn Group and the undifferentiated fill.

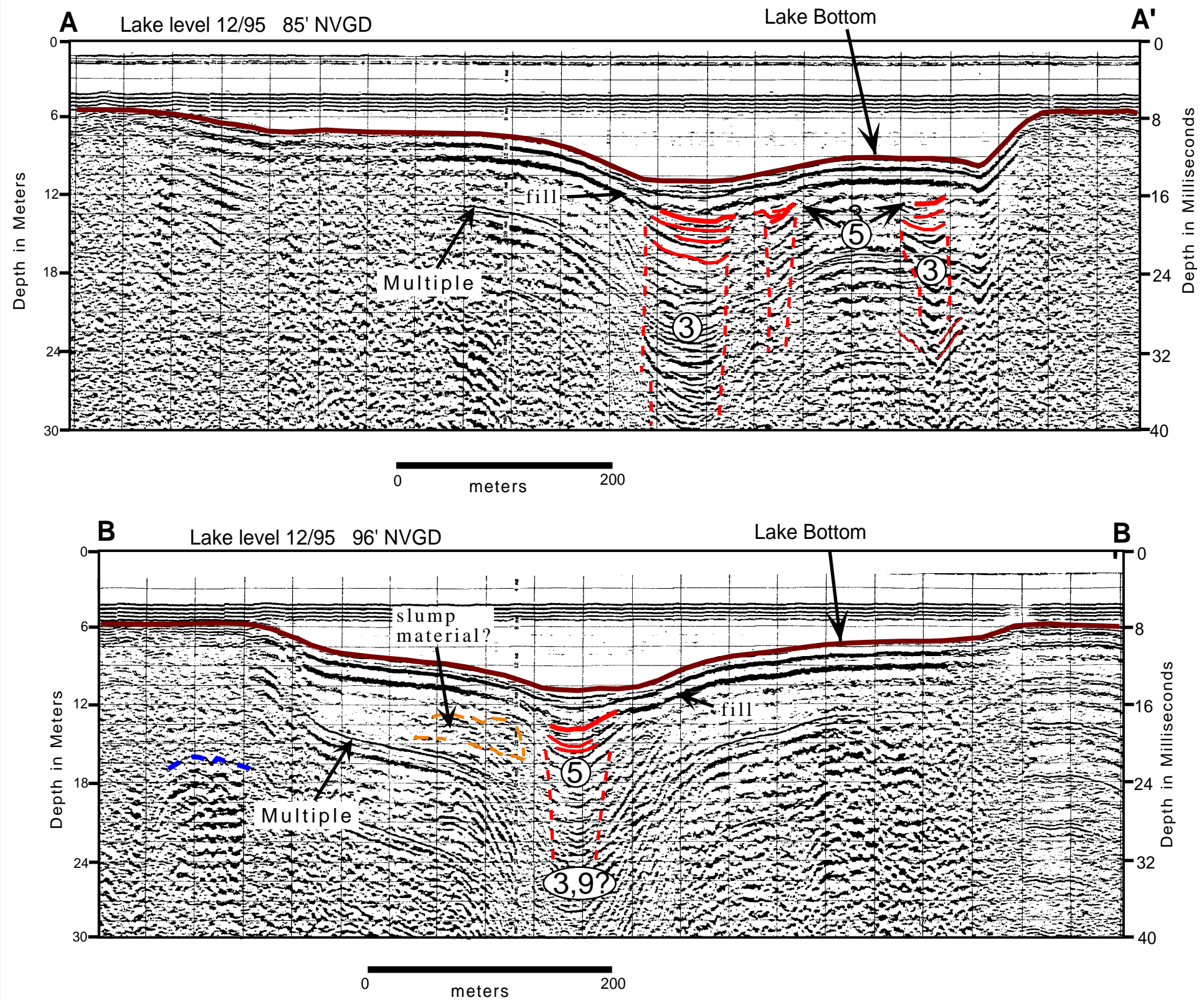
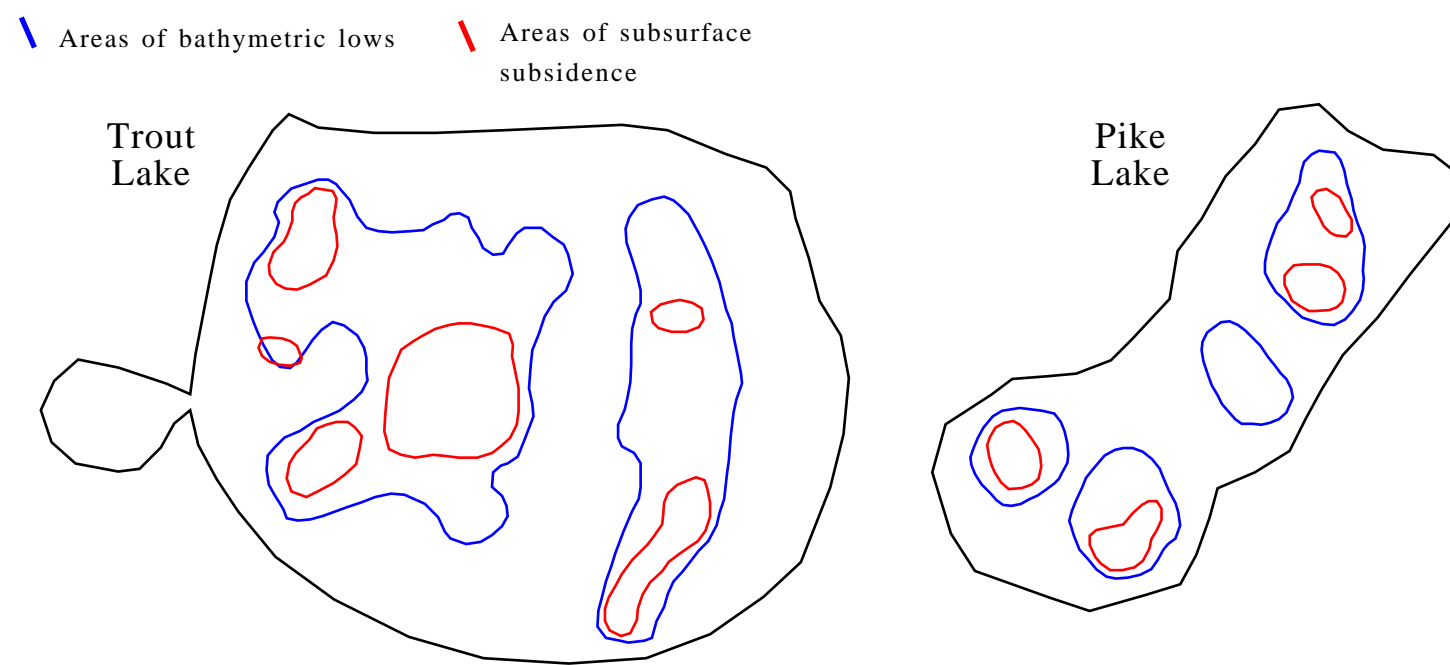
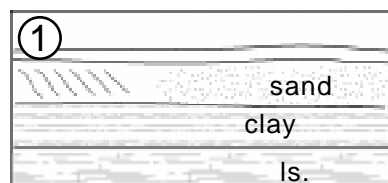


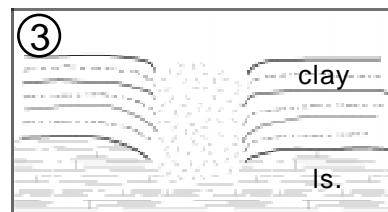
Figure 1. Distribution of features interpreted from seismic profiles.



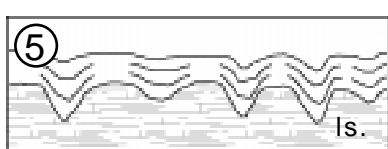
EXPLANATION



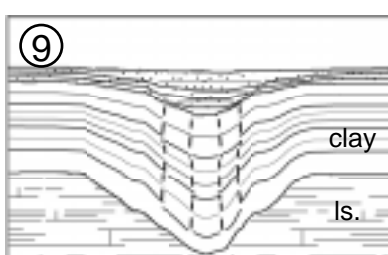
Undisturbed section, with or without upper non-reflective sand layer. Sand layer may show reflection where cross bedding from original deposition (fluvial or aeolian) exists. Clay layers are mostly intact.



Horizontal reflectors continuous on either side of a central non-reflective zone. Horizontal layers bend downward towards the central zone. These features are representative of filled collapse sinks. The size may range from tens of meters to kilometers across a lake basin.



Numerous small features with high angle reflectors dipping toward their center. These features may represent localized collapse sinks or filled solution pipes.



Low- to mid-angle subsidence depressions. Parallel reflectors have undergone displacement and rotation, creating stress fractures and faulting within the depression. The subsidence may or may not be filled with overburden.